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THE PENNATULACEA

BY

SYDNEY J. HICKSON, F.R.S.

WITH TWO TEXT-FIGURES

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INTRODUCTION.

The collection of Pennatulacea made by the Murray Expedition does not include any new species. All of them, with one exception (*Pteroeides* sp. ?), belong to species which have previously been described and well illustrated; but it is, nevertheless, a collection of considerable interest and importance. Some species, of which only a single or less than half a dozen specimens have been previously recorded, are represented by a large number of specimens, providing material for the study of growth and variation, and in one case (*Umbellula huxleyi*) proving that several previously described species are only growth stages or varieties of one widely distributed species. Some interesting facts concerning the geographical distribution of the deep-sea Pennatulacea are also revealed. For example, the very rare and remarkable species *Chunella gracillima* was found to exist in great numbers in the Pemba Channel, where it was first discovered by the "Valdivia" expedition. It was associated in both collections with *Funiculina quadrangularis*. The only other locality in which *Chunella gracillima* has been found is in the Bali Sea of the Malay Archipelago. Here also it was associated with the only specimen of *Funiculina* obtained during the voyage of the "Siboga".

If, as there is now good reason to believe, several species of *Umbellula* from the Indian Ocean, described by previous authors as new to science, are only growth stages or varieties of *U. huxleyi* (Köll.), this species, like many others from the deep sea, has a very wide geographical distribution, extending perhaps as far East in the Pacific Ocean as Hawaii, where a very similar form called *U. jordani* is said to occur (Nutting, 1908, p. 564).

The very large number of specimens of *Cavernularia orientalis* from one locality enabled me to confirm the wide range of variation that I found in a smaller collection of the same species from Amboyna (1916, p. 55), and to compare them with *Cavernularia darwinii* from the Pacific coast and neighbouring islands, which seems to be closely related to it.

Our knowledge of the sexual periodicity of both deep- and shallow-sea Pennatulacea is far too incomplete to enable us to form any definite conclusions on the subject, but the sexual condition of all the species has been noted. If the spawning time is annual and constant, then *Chunella* becomes ripe in January, *Umbellula huxleyi* in May and *Pennatula*

inflata probably in April. The gonads of *Protoptilium* indicate a spawning time about March. No gonads were observed in *Cavernularia* at the beginning of December, nor in *Scytalium* in March.

I wish to express my thanks to Col. Sewell for valuable advice and assistance, and to Prof. J. Stanley Gardiner for allowing me full facilities to work in the Department of Zoology in Cambridge.

August, 1936.

Cavernularia orientalis Th. and S.

1909. *C. orientalis*, Thomson and Simpson, " Investigator " Reports, Pt. II, p. 175.
1911. *Cavernulina cylindrica*, Kükenthal and Broch, " Valdivia " Reports. Pennatulacea, p. 175.

Occurrence.—Station 80, off the coast of Oman, near Muscat, 16 to 22 metres, Nov. 30, 1933 ; about 220 specimens of this species.

Descriptive Notes.—The examples ranged in total length from 16–80 mm. They have the usual club shape of Cavernularias preserved in spirit, the diameter gradually decreasing from near the top of the rachis to the end of the stalk. There is no marked constriction between rachis and stalk.

In a specimen 50 mm. in length the thickest part of the rachis is 10 mm. and the middle part of the stalk 5 mm. in diameter. These measurements represent only those of contracted preserved specimens and are of little scientific value, as we have no knowledge in this case of the diameters of the species when fully expanded (see p. 115, *C. malabarica*).

One of the characters that is frequently used for the determination of the species of Pennatulacea is the ratio of length of rachis to the length of stalk. The large number of specimens in the collection enabled me to test the validity of the character in this species, and I made the following measurements in millimetres :

T.		R.		S.		T.		R.		S.
18	=	6	+	12	.	60	=	35	+	25
22	=	8	+	14	.	60	=	32	+	28
35	=	10	+	25	.	80	=	45	+	35
65	=	28	+	37	.	80	=	50	+	30

Where T. = total length, R. = length of rachis, and S. = length of stalk.

These figures show that the ratio is very variable in this species and of no value for systematic purposes. The only result obtained is that in the small examples the stalk is longer than the rachis and that in the larger ones the rachis is longer than the stalk.

The boundary line between rachis and stalk is sometimes irregular and often difficult to determine, but there is never any projection upwards of the stalk into the rachis indicating an incipient bilaterality such as is found in *Echinoptilum*. The colonies are therefore quite radially symmetrical.

The autozooids are irregularly scattered all round the rachis, and each one is surrounded at the base by a small area free from spicules. There is no trace of a shelf or other form of verruca (calyx) as in the S. African genus *Actinoptilum*.

A few anthocodiæ were found fully expanded. The length of the body is 2·5 mm. and of the tentacles 1·5 mm. Each tentacle bears about nine pinnæ each side. There are no spicules in any part of the anthocodiæ.

The siphonozooids are also scattered. There is no arrangement of them on definite lines as in some other species of the genus.

The axis was present in all the specimens examined, but in no case extended through the whole length of the colony. In a specimen 80 mm. in length it was 25 mm. in length, one-third of it in the rachis and the rest in the stalk. In another, 22 mm. in length, it was 8 mm., of which only 1 mm. was in the rachis.

In both cases the extremities of the axis were very powdery in texture, and probably a short length of unintegrated axis was lost in the dissection.

The intact part of the axis is in section square, with rounded edges, and the greatest diameter of the larger ones is a little over 1 mm.

As several species of the genus have been described on the examination of one or only a few specimens, and as the presence or absence of an axis was one of the characters on which such species have been founded, it was clearly important to determine if this character is constant or variable. In the dissection of six other specimens of various sizes I found the axis square in section, occupying the same position relative to the rachis and stalk, and by probing twenty other specimens with a needle I found full confirmation of this presence and position of the axis.

The conclusion is that, in this species, the presence and relative length of the axis is constant. But Balss (1910, p. 83) found that in specimens from the same locality of *Cavernularia harbereri* an axis is present in some, but not in others.

This point is of some theoretical importance, because if the axis in these radially symmetrical forms is found to be variable, it may be taken as a sign that it is degenerating, but if it is fairly constant in size in each species, there is no reason to assume that it is what is often called a " rudimentary " structure.

I have already given (Hickson, 1918, p. 131) my reasons for believing that these radially symmetrical families are the most primitive of the Pennatulacea, and that in them we find, not the degeneration, but the evolution of the axis.

Spicules.—The most characteristic feature of this species is the shape of the spicules of the rachis. Instead of the usual straight needles of most of the species of the genus, many of them are branched or knobbed at one or both extremities. Some of them have an outline not unlike that of a flattened metatarsal bone with two or three rounded epiphysis-like processes at both ends ; in others these processes are triangular and pointed at the end (Text-fig. 1). A few spicules may be found which are shorter and thicker, corresponding with the type which A. Thomson called " capstans ".

The longest of these in a specimen 80 mm. in length is about 0·3 mm., but they are very variable in size. These are the characteristic spicules, but in addition there are numerous other, but mainly smaller, spicules which are smooth spindles, rods and other indeterminate shapes.

In a specimen 50 mm. in length there were not so many of the characteristic spicules in the rachis, and the largest of them were only 2 mm. in length (Text-fig. 1). In the smallest specimen examined, 22 mm. in length, these spicules were very scarce and had a maximum length of only 0·15 mm. (Text-fig. 1).

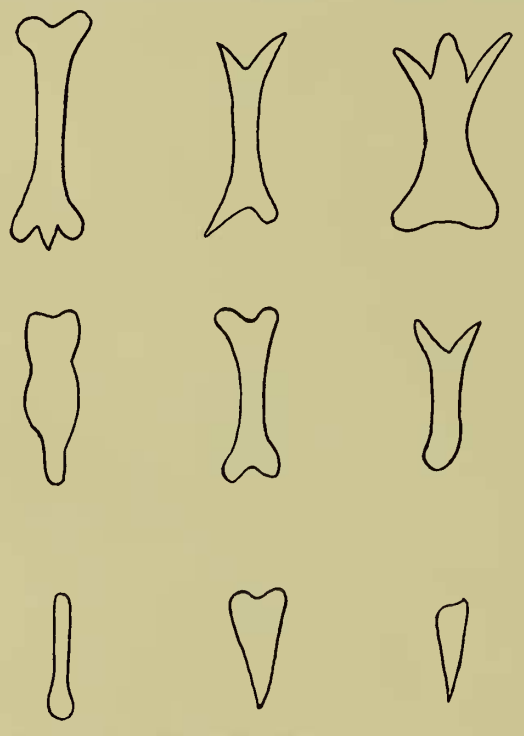
When preparations of spicules from specimens of different sizes are examined a great

range of variation may be observed both in size and shape, but it is obvious that they increase in size with the growth of the colony, and that the characteristic shapes of most of them are only attained in the full-grown colonies.

But when preparations of specimens of the same size (viz. 80 mm.) are examined a considerable but not so wide a variation in the spicules of the rachis may also be found.

It may be noticed that when I examined four specimens of the same species from Amboyna (1916, p. 53, text-fig. 9), a similar wide range in the variation of the spicules of the rachis was recorded.

The spicules of the stalk are confined to a layer at the surface about 0·3 mm. in thickness where they are densely packed together. Below this layer there is a spongy



Text-fig. 1.—Spicules of the rachis of *Cavernularia orientalis*. Top row of a specimen 80 mm. in length; middle row of a specimen 50 mm. in length; bottom row of a specimen 22 mm. in length. All × 66 diam.

tissue, 0·3 mm. in thickness, and below that again muscle bands, 0·6–0·8 mm. thick. No spicules of any kind were found below the surface.

When separated and mounted these spicules are bean- or pod-shaped, and in the largest specimens about 0·2 mm. in size (Text-fig. 2). In the smaller specimens they are of approximately the same shapes but not so large. No bone-shaped or bifurcated spicules were found in the stalk.

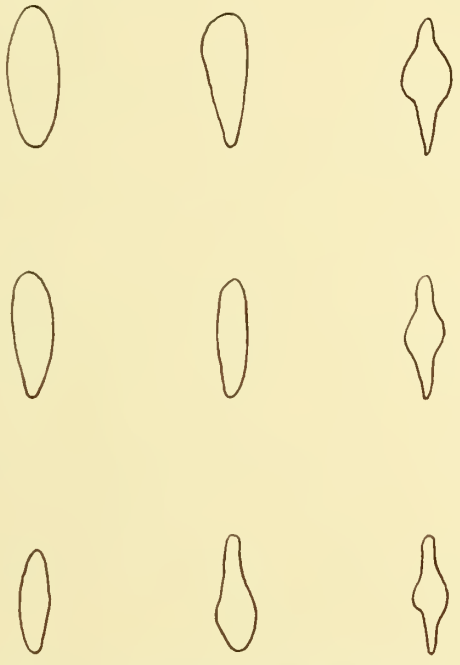
Colour.—A very noticeable feature of most of the specimens of the species in this collection is the pale amethyst colour of the rachis. The only reference I can find to the presence of a colour of this kind in a species of *Cavernularia* is that by Thomson and Simpson (1909, p. 306), in which they say that in two specimens of *C. lütkeni* from the Orissa coast the colour was "purplish".

Gonads: No gonads were seen by a lens in any specimen. November–December is therefore not the spawning-time of this species.

The type of this species was described by Thomson and Simpson (1909, p. 305). It was found off the coast of Orissa, but the depth was not given in the text. In size, characters of the spicules, the length and relations of the axis, it agrees very closely with some of the specimens in the "Murray" collection.

Two years later Kükenthal and Broch described a specimen from Amboyna in the Vienna Museum, for which they constituted a new genus *Cavernulina* and called it *C. cylindrica*. They expressed the opinion that it was closely related to Thomson and Simpson's *Cavernularia orientalis*.

In 1916 (p. 52) I described four specimens from Amboyna which I referred to Thomson and Simpson's species, and gave reasons for not accepting the new generic name



Text-fig. 2.—Spicules of the stalk. Top row of a specimen 80 mm. in length; middle row of a specimen 50 mm. in length; bottom row of a specimen 22 mm. in length. All × 66 diam.

Cavernulina, nor the distinction between Kükenthal's type and *Cavernularia orientalis*. The discovery of *Cavernularia darwinii* in the Galapagos Islands gives another point of interest to this species.

Note on *Cavernularia darwinii*.

A single specimen of a *Cavernularia* was found by Charles Darwin in the Galapagos Islands in 1835, but it was not examined or described until 1921 (Hickson, 1921, p. 372). At that time it was the only specimen of the family Veretillidæ known to occur on the Eastern side of the Pacific Ocean. Quite recently, however, Miss Deichmann (1936, p. 4) has described a species under the name *Veretillum binghami* from the Gulf of Lower California which cannot be separated from the Galapagos species, and by her kindness, and that of Dr. Schmitt of the Smithsonian Institution, I have been able to examine a specimen of the same species obtained by the "Albatross" Expedition from the coast of Ecuador. There can be no doubt that the Galapagos specimen and the specimens from the tropical Pacific coast of America all belong to the same species.

Cavernularia darwinii should be regarded as a distinct species from *C. orientalis*, but the resemblances between them are so remarkable that they are deserving of special consideration.

In both species there are present in the rachis bone-shaped spicules, an incomplete axis supports the colony, the spicules of the stalk are confined to a layer at the surface and there are no spicules in the anthocodiæ. As regards the relation of stalk to rachis the following figures are of some interest.

	T.		R.		S.
**C. darwinii* (Galapagos) . .	90	=	55	+	35
C. darwinii (Ecuador) . .	95	=	60	+	35
C. orientalis	80	=	45	+	35
,, ...	80	=	50	+	30

Where T. = total length, R. = length of rachis, and S. = length of stalk.
Measurements in millimetres.

It will be noticed that the total length of the only specimens of *C. darwinii* I have measured is greater than that of any of the specimens of *C. orientalis* in the " Murray " collection, and the rachis is relatively a little bit longer. Miss Deichmann's type-specimen was much larger, being 250 mm. in total length, and the stalk is said to be " $\frac{1}{4}$ to $\frac{1}{3}$ of the entire length of the colony " in the three specimens she examined.

The relatively greater length of the rachis in these large specimens is what might be expected from the figures given above on p. 110. But, notwithstanding these resemblances between the two species, a comparison of preparations of spicules of the rachis shows that they can be readily distinguished, the most noticeable difference being that the characteristic spicules of *C. orientalis* are nearly twice as long as those of *C. darwinii*. In the largest specimens of *C. orientalis* they attain to a length of 0·3 mm.; in the still larger specimens of *C. darwinii* they are only 0·15 mm. in length. For this reason the two species may be considered to be distinct.

The opportunity here afforded may be taken to announce that the type-specimens of *C. darwinii* and of *Gorgonia darwinii* collected by Charles Darwin in the Galapagos Islands, together with my preparations made from them, have now been transferred to the British Museum.

Note on Another Species of *Cavernularia*.

Most of the species of *Cavernularia* are inhabitants of shallow coastal waters, and it is probable that, in normal life, they are lightly attached by their stalk to a sandy or muddy bottom. There are only two records of specimens of this genus being washed ashore, one on the coast of Orissa, and the other on the coast of Borneo (Hickson, 1921, pp. 370 and 373). The former were referred to the species *C. malabarica*, Fowler, and the latter to *C. chuni*, Kükenthal and Broch. The specimens collected by Dr. Hose after a storm at Miri, in Borneo, are all tightly contracted, but they agree very closely with the description of the type of *C. chuni* (Kükenthal & Broch, 1911, p. 190).

The type-specimen of Fowler's (1894, p. 376) *C. malabarica* and the specimens collected by Dr. Imms on the Orissa coast are fully expanded.

* By an oversight in correcting the proof of the original description of *C. darwinii* the figures given for the lengths of rachis and stalk were not correct. The figures given here are of a re-measurement of the type-specimen.

The diameter of the rachis of the Borneo specimens is only slightly greater than that of the stalk, but the diameter of the rachis of the Orissa coast specimens is at least twice that of the stalk.

Apart from this character the specimens are in close agreement, and after further investigation I have come to the conclusion that *C. chuni* is identical with *C. malabarica*.

The diameter of the rachis is a character which depends entirely on the degree of contraction of the specimen when preserved and is of no systematic importance.

The special points of interest that all these specimens have in common are the remarkably short stalk and absence of an axis. They seem to indicate that their power of attachment to a muddy or sandy sea bottom must be much less than that of other species with a long stalk and an axis with its strong muscular attachments. The absence of an axis and its muscles makes them lighter than other species, and it seems probable therefore that their usual habit is to float or drift about in the sea like a *Pelagohydra*, and therefore are washed ashore sometimes after a storm.

The consideration of these specimens confirms the view that I ventured to put forward in 1918 (p. 131) that in these radially symmetrical Veretillidæ we have the most primitive forms of the Pennatulacea.

Funiculina quadrangularis Pallas.

Pennatula quadrangularis Pallas, Elench., 1766, p. 372.
Kükenthal and Broch, " Valdivia " Reports, p. 243.

Occurrence.—Stations 108 and 122, in the Pemba Channel, 786 and 732 metres respectively ; several specimens of a Pennatulid, which could be identified as a species of *Funiculina*. They were associated with specimens of *Chunella gracillima*.

Descriptive Notes.—The examples were in such a bad state of preservation that only small patches of a soft black fleshy substance remained attached to the axis. When washed and cleared in oil these fragments showed the characteristic spicules of the genus and some characters of the autozooids top rove that they belong to the genus *Funiculina*. It seems very probable that the deplorable state of these specimens was not due to the process of preservation in spirit, but to a moribund and partly macerated condition when captured.

It is quite impossible to determine the species of *Funiculina* to which they belong, but there are some reasons for referring them to the old and widespread species *F. quadrangularis* of Pallas. The " Valdivia " expedition obtained about 200 specimens of a *Funiculina* from the same station in the Pemba Channel as that from which *Chunella gracillima* was found, and Kükenthal and Broch (1911, p. 243) were able to give accurate measurements of 88 of these and write a full account of the anatomy of the species.

There can be no doubt that the " Valdivia " specimens were much better preserved than those obtained by the " Murray " expedition, and, therefore, their reference by the authors of the report to *Funiculina quadrangularis* must be accepted.

The most interesting feature about them is that they confirm the association of *Chunella* and *Funiculina* in the Pemba Channel, previously discovered by the " Valdivia " expedition. As an example of an association of two genera in a restricted locality it is not by itself very remarkable ; but in the Malay Archipelago the only specimen of *Funiculina* found in the very extensive " Siboga " collection came from the same station as the specimens of *Chunella gracillima*. But *Funiculina* has been found in the Indian Ocean elsewhere than associated with *Chunella*. Thomson and Henderson (1906A, p. 110)

described one specimen of *F. quadrangularis* and several specimens of a new species which they named *F. gracilis* from deep water in the Bay of Bengal, and there is one specimen in the " Murray " Expedition collection from Station 143 in the Maldive Archipelago.

No general description of these specimens can be given. In the collection there were very many bare axes which might have belonged either to the *Chunella* or the *Funiculina*. Fragments of *Funiculina* flesh were found on only a few of them, but it is worth noting that one of these was nearly 1 meter in length. The longest specimen of this species in the " Valdivia " collection was only 693 mm. in length.

Protoptilum cyaneum Kükenthal.

P. cyaneum, Kükenthal and Broch, " Valdivia " Reports, 1911, xiii, heft 2, p. 257 (70 specimens).

Occurrence.—Station 16, off Berbera in N. Somaliland, 186 metres.

Descriptive Notes.—The type of this species was the only specimen obtained by the " Valdivia " Expedition. It was found in 1242 metres of water off the coast of Somaliland. Although the type came from much deeper water than the specimens in this collection, there can be no doubt that they all belong to the same species.

The autozooids of some of the specimens have the pale blue colour which gave the species its specific name " *cyaneum* ", but in the majority there is no blue colour, the whole colony being pale-cream or colourless. I am informed by Col. Sewell that the colour of these Pennatulids when captured was a " reddish tint " which dissolved in spirit.

The type-specimen, which was only 114 mm. in total length, was probably a young or juvenile form.

The largest specimen in the " Murray " collection was 430 mm., the smallest 240 mm. in length. The average length of all the specimens cannot be given as so many of them were imperfect, but the majority were certainly over 300 mm. in length. It is unfortunate that no small or very small specimens were found, as very little is known about the growth stages of the species of this genus, and such specimens might have thrown some light on the true systematic position of several species which have been given separate generic names (see Hickson, 1916, p. 96).

In the original definition of the species the stalk was said to be one-third of the total length. This ratio, however, was found to be much more variable than was expected. In the largest specimen, 430 mm., the stalk was 200 mm. in length ; in the smallest, 240 mm., the stalk was 60 mm. in length, and in four specimens, ranging from 280–380 mm. in total length, the stalk was approximately a third of the whole length. The ratio varies therefore from 2 : 1 to 4 : 1, and apparently the relative length of the stalk increases with the increase in the total length.

The autozooids are protected by a well-developed calyx terminating in six projecting tooth-like groups of spicules. These processes are so frequently broken in the actual specimens that it is difficult to determine whether the number six is absolutely constant. The total length of the calices is approximately 4·5 mm. They are distributed unevenly on the ventral and lateral sides of the rachis. In some specimens they are arranged on some parts of the rachis in oblique rows of three, in others there is a rough arrangement in two or three longitudinal rows, but taking the specimens as a whole there is not any very constant arrangement of the autozooids.

The siphonozooids are very numerous. There is a dense longitudinal row of them

on each side of the dorsal track and many others between the autozooids. They can be seen as low verruciform projections from the surface about 0·15 mm. in diameter in some specimens, but in others they are almost completely hidden.

In the description of the type-specimen Kükenthal and Broch give as a distinguishing feature of the species the character that the siphonozooids are scarce (sehr spärlich). At first sight this might be thought to be the case with some of the "Murray" specimens, as these zooids can hardly be seen even with a simple magnifying glass. When, however, slices of the rachis are decalcified and stained, the siphonozooids are found to be quite as numerous in these specimens as in those with visible verrucæ.

The most important character of the siphonozooids is that, as in the type-specimen, they are not supported by a definite calyx of spicules. The consequence is that in some forms of contraction they are completely covered and hidden by the dense layer of spicules of the surface of the cœnenchym.

The long slender stalk is completely cylindrical in shape and terminates below in a well-marked bulbous expansion. In these preserved specimens there is considerable variation in the size of this bulb, but in specimens 300–400 mm. in length it is about 10 mm. long by 4 mm. in diameter. The axis is cylindrical throughout its whole length, the greatest diameter being about 0·75 mm. The spicules are of the usual 3-flanged type and reach a maximum length of about 1 mm.

Gonads: Several specimens were examined, but only in two of them were gonads observed. One was a female with ova less than 0·1 mm. in diameter, and the other was a male with testes of about the same size. It is certain that they were not nearly ripe, but it is impossible to form a definite opinion as to the time of year when they might be expected to spawn. They were captured on October 21st, and, if we may judge from our knowledge of some other Alcyonaria, it is unlikely they would spawn before the end of the year, but more probably not until March of the following year.

The *Protoptilum cyaneum* of the coast of Somaliland is the only species of the genus that has been found in the Indian Ocean. Three species are known from the Atlantic Ocean, one from the Malay Archipelago, one from Hawaii and one from Japan. The only one of these that is allied to *P. cyaneum* is *P. denticulatum*. This species was described from a single specimen found at the great depth of 1695 fathoms in the Atlantic Ocean 58° 20′ N., 40° 48′ W. (Jungersen, 1904, p. 89). It had a total length of only 75 mm., and may be, therefore, only a young stage in the growth of a much larger specimen. However, even in this young stage, the siphonozooids possess a well-defined calyx provided with two teeth, and judging from Jungersen's description and figures they are numerous, but not so numerous as in *P. cyaneum*. There is, therefore, no reason to suppose that the Somaliland species is identical with *P. denticulatum* or any other species of the genus.

Chunella gracillima Kükenthal.

C. gracillima, Kükenthal and Broch, 1911, "Valdivia" Reports, p. 272.
C. gracillima, Hickson, 1916, "Siboga" Reports, p. 111.

Occurrence.—There were three tubes in the collection containing specimens of *Chunella* from Stations 108, 122 and 124, at depths of 786, 762 and 914 metres respectively, and two jars containing hundreds of pennatulid axes from Stations 108 and 122, which most probably are the axes of this *Chunella* and of *Funiculina*. All these stations were in the Pemba Channel.

Distribution.—It is interesting to note that it was from this locality that the " Valdivia " expedition obtained the original type-specimens which Kükenthal and Broch (1911, p. 272) described as *Chunella gracillima* and *C. quadriflora*.

Two specimens of the same species were found by the " Siboga " expedition (Hickson, 1916, p. 111) at a depth of 1018 metres in the Bali Sea in the Malay Archipelago. I can find no record of the occurrence of the species in any other locality.

Descriptive Notes.—I am informed by Col. Sewell that the autozooids of *Chunella* when captured were of an " indigo blue colour ", but this colour dissolved in the spirit.

In all the vessels there were found, in addition to the *Chunellas*, whole specimens or fragments of *Funiculina quadrangularis*, and in the tubes there were pieces of the glass-like rods of the sponge *Haliphysema*. From the first two tubes examined I was able to unravel thirteen unbroken specimens of *Chunella*. In the third tube the specimens were in such an elaborate tangle that it was impossible to form even a reliable estimate of the number present, or to measure any one of them. In the two jars there were numerous Pennatulid axes coiled up in bundles. On some of these there were fragments of the flesh of *Chunella*, on others of the flesh of *Funiculina*. At a rough estimate there were about 100 specimens of the two genera represented by whole specimens, bare axes or fragments. It is quite evident that at depths of 700–1000 metres in the Pemba Channel this rare deep-sea Pennatulid, accompanied by *Funiculina*, exists in great numbers.

Unfortunately none of the specimens were very well preserved. In the rough and tumble of coming up from a great depth in a dredge and then being packed away in tubes a good deal shorter than their total length many of them were broken, and the soft flesh covering the axis rubbed off in places, or wholly. All this was doubtless quite unavoidable but the collection is nevertheless of considerable scientific interest.

These long and very slender sea-pens bear at variable intervals of 50–60 mm. apart whorls of three autozooids. Up to the present time the total length has been measured and the number of whorls recorded of four specimens, two from the Pemba Channel by Kükenthal and two from the Bali Sea by myself. The total length of the thirteen specimens of the " Murray " collection that were measured varied in total length from 300–670 mm. Among these, one, 590 mm. in length, had six whorls ; two, each 470 mm. in length, had five whorls ; four, measuring 300–400 mm. in length, had three or four whorls.

In this statement the number of whorls actually preserved is given. It is possible that in some cases one or more whorls have been lost. In a specimen, for example, 670 mm. in length there were only four whorls preserved and probably two or three have been lost. Comparing these results with those of previous descriptions of the species we find a general agreement. Kükenthal's two specimens were 580 and 365 mm. in length and had five and four whorls respectively. The specimen 755 mm. in length collected by the " Siboga " expedition had nine whorls, but the smaller one 365 mm. in length had five whorls. Thus, roughly speaking, and leaving room for some variations, the progress of whorl development in the species may be represented by the following figures :

Total length in mm.	Number of whorls.
300–400	3–4
400–500	4–5
500–600	5–6
700+	9

The third, fourth and fifth whorls from the free end of the colony bear three autozooids; the first and more rarely the second bear only two autozooids, although a rudimentary third may be visible.

Kükenthal (1911, p. 275) described a specimen which he called *C. quadriflora*, from the same locality in the Pemba Channel as that of *C. gracillima*, in which the second and third whorls bore four autozooids.

I have examined a great number of the whorls of the " Murray " specimens and have not found a single one with more than three autozooids. The existence of *C. quadriflora* in the Pemba Channel cannot, therefore, be confirmed.

The axis of all the specimens is, as previously described, quadrangular, with very rounded angles, becoming cylindrical below and drawn out to a very fine thread at the distal ends. The greater diameter of the axis in the lower end of the stalk of a specimen about 400 mm. in length was 0·9 mm., and of the terminal thread about 0·28 mm. The axes of the *Funiculina* from the same dredging are also quadrangular and drawn out to an exceedingly fine thread at the distal ends.

It is very remarkable that in two genera of Pennatulids so far apart systematically as *Chunella* and *Funiculina* the axes should be so much alike that in external characters they are indistinguishable. There may be differences in histological detail which I have not discovered, but pieces of the axis of the two forms exposed to an acid for several days revealed no noticeable differences.

The material was not sufficiently well preserved for making satisfactory preparations to illustrate the finer details of the structure of the soft parts, but I have found no reason to doubt the accuracy of previous descriptions of the autozooids and of the distribution of the siphonozooids.

Gonads : All the autozooids of the larger specimens were packed full of gonads, which from the appearance of the nucleus of the ova seemed to be nearly ripe. The largest gonads were over 1 mm. in diameter. All the specimens were collected in the month of January.

Umbellula huxleyi Kölliker.

U. huxleyi, Kölliker, 1880, " Challenger " Reports, Zool., I, p. 21.

Occurrence.—(i) Station 194, off Aden, 220 metres ; about 240 specimens of a species of *Umbellula* were obtained. (ii) Station 185, off S. coast of Arabia, not far from Aden, 2001 metres ; one specimen of the same species. (iii) Station 143, Maldive Archipelago, 797 metres ; three specimens.

Descriptive Notes.—A detailed examination of all these specimens has not been made, but the principal characters of six selected examples have been determined, and certain special features of many other specimens have been noted. There can be no doubt that they all belong to the same species, but it has not been an easy task to determine which of the many species of similar Umbellulas in the literature of the subject they should be referred to. This problem is discussed below.

The largest specimen is 300 mm. and the shortest 130 mm. in total length.

The number of autozooids in the terminal tassel is very variable, but, roughly speaking, the number increases with the increase in length and in age (?). The exact number cannot be determined by a superficial examination with a lens. The only accurate method is to

cut off the autozooids one by one and count them as they fall; but as this is a very destructive method, I have used it only on a few specimens. The results were as follows: A specimen 250 mm. in length bore 28 autozooids, a specimen about 200 mm. bore 22 autozooids, and the smallest I could find, 130 mm. in length, bore only 6 autozooids.

The size of the autozooids in the preserved specimens is even more variable; the length of the body, apart from the tentacles, may be 20 mm. in big specimens, and only 4 mm. in small ones, but there is a wide range in length according to their degree of contraction. As the specimens were dredged and preserved at the same time it might have been expected that the contraction would be the same in all cases; but there is another factor which influences the length of the autozooids. In most of the specimens the body cavities of the autozooids and even the cavities in the tentacles are packed with gonads; in others there are no gonads. The autozooids in the former case are long and comparatively slender and the tentacles are usually fully extended; the autozooids in the latter are short and sometimes globular in shape, and the tentacles are either very short or broken off and lost.

This gives the autozooids of the pregnant and the shotten specimens a very different appearance, and it is obvious that the pregnancy offers a physical impediment to contraction.

It is usually quite easy to recognize without dissection the ripe from the barren autozooids, as in the former the gonads are clearly indicated by rectangular areas on the surface of the body-wall. Such markings are clearly shown in Kölliker's figure (1880, pl. ix, fig. 37*a*) of *Umbellula huxleyi*, and in Kükenthal and Broch's picture (1911, pl. xvi, fig. 17) of *U. spicata*. In the picture of *U. pellucida* (pl. xvi, fig. 20) by the authors of the '"Valdivia" Reports' the autozooids are strongly contracted, and there are no quadrangular markings on the body-wall. Moreover the specific name "pellucida" could not have been reasonably applied to polyps pregnant with gonads. No mention is made in the "Valdivia" report of the sexual condition of any of the species, but there can be little doubt that the two species *U. spicata* and *U. pellucida* are only pregnant and barren forms of the same species. Both species were dredged off the coast of Somaliland, and I can find no reason to separate them from the species collected by the "Murray" expedition, which I have identified as *U. huxleyi*.

Gonads: The gonads of several specimens were examined. The largest measured were about 0·8 mm. in diameter, as preserved, and judging from their histological condition they were very nearly mature in both sexes. All the autozooids of a specimen were either male or female. There was no case of hermaphroditism or of viviparity. The specimens were collected on May 2nd, 1934.

Exact information concerning the time of spawning and its duration and of the manner of discharge of the gonads is lacking and may never be obtained, owing to the great depth in which these animals live, but as the specimens were collected in the month of May it seems probable that they are discharged late in May or early in June.

The extraordinary fecundity of the polyps and the very large size of the ripe ova make it difficult to believe that they are discharged one by one by the mouth. There may be another method of discharge, and it may be suggested that this is afforded by the detachment of the tentacles. If so it accounts for the absence of the tentacles from so many of the shotten autozooids.

In many of the descriptions of the species of *Umbellula* diagrams are given showing the arrangement of the autozooids on the rachis. In some species the arrangement is said to be bilateral, and in others in concentric circles. In the diagrams of five specimens of *Umbellula pellucida* given by Kükenthal and Broch (1911, pp. 301 and 302) the arrangement is quite irregular, but in the diagnosis of the species it is described as " in annähernd koncentrischen Kreisen ". Moreover, it may be observed the arrangement is not the same in any two of the five specimens attributed to this species.

I examined this character in four specimens. In one it was roughly bilateral, in another the autozooids were arranged in irregular concentric circles, and in the other two there seemed to be no definite arrangement. It seems consequently that this character is so variable as to be of no systematic value.

I have made no attempt to give a complete record of the distribution of the siphonozooids, as the specimens are not sufficiently well preserved to provide reliable results.

In former papers (1907, p. 13, and 1916, p. 117) I have discussed the value of siphonozooids for systematic purposes. The discovery of siphonozooids on the stalk, even as far down as the bulb at the base, many of which are quite invisible from a surface view, requires, for a complete record of their distribution, not only very well preserved material, but series of stained sections from regions through the whole length of a specimen. Without these conditions results may be very misleading.

The presence of a single tentacle on these zooids is very difficult to deny for any specimen, dredged up from such depths and roughly preserved, as they are very easily detached and lost. All that can be said definitely about the specimens of the " Murray " expedition is that the siphonozooids of the rachis have a stomodæum about 0·14 mm. in length and support one pair of long mesenteric filaments. Tentacles were not observed on any of them.

The axis in all the specimens is quadrangular in section ; that is to say, it is marked by four shallow longitudinal grooves with four prominent rounded ridges. At the stalk end the ridges become shallower, and for a considerable distance the axis becomes almost circular in section. The greatest width of the axis of a large specimen is 1 mm.

There are no spicules in the autozooids nor in any part of the rachis.

The Problem of the Species.

In the whole literature of the Alcyonaria there is no worse example of the unnecessary multiplication of species than is found in the history of this genus.

In the early days specimens of *Umbellula* were rarities, and systematists gave a new specific name, often quite justifiably, to every new specimen that was found. But with the increase in our knowledge of the fauna of the deep seas the number of specimens available for examination rapidly multiplied and the unfortunate habit continued. The result of this has been that some forty species of *Umbellula* have been described, of which probably less than one-half will prove to be valid.

We have a good example of this in the Umbellulas of the Indian Ocean. No less than 11 species have been described from this region which agree in having comparatively small autozooids, which bear no spicules, in having a long, very slender stalk with a small terminal bulb and a square axis.

In the description of these species no consideration has been paid to the possibilities of variation, to the effect of changes due to rough capture or preservation, or to the sexual

condition. There is also no clear indication given of the essential characters of the species or of their relations to one another.

Of the 11 species, five were described from 1 specimen each, 1 from 2, two from 3, one from 4, and one from 8 specimens. In the description of one species the number of specimens was not recorded. It is obvious that in most of these cases the study of variation was not possible. As all these species inhabit considerable depths of water (100–1000 fathoms), it is inevitable that there must be considerable changes in their appearance before they come on deck, to say nothing of subsequent changes due to imperfect preservation. Single specimens obtained in a haul of the net, if not injured by mud, stones and other objects in their passage from the bottom, are often well preserved, but if a net comes up packed with booty of various kinds specimens of *Umbellula* are often seriously damaged. The result of this is that specimens which really belong to the same species may, when examined in the laboratory, have such a different appearance that, unless they are critically considered, they may be regarded as representatives of distinct species.

That there is only one species in this large collection made by the "Murray" expedition is a view which for many reasons must be accepted.

It is very improbable that a large number of specimens belonging to the same genus, and all in approximately the same sexual condition, living in the same locality in deep water, should belong to more than one species. Any cross-fertilization that might occur would soon swamp any specific distinctions.

A careful examination of the whole collection revealed no discontinuity. From the largest to the smallest there was a continuous series without any well-marked break.

On the Probable Synonyms of *U. huxleyi*.

Four of the species collected by the "Valdivia" expedition, *U. spicata*, *U. valdiviæ*, *U. köllikeri* and *U. pellucida*, came from the coast of Somaliland, or of equatorial E. Africa; one, *U. rigida*, from the neighbourhood of the Chagos Archipelago.

Five species, *U. purpurea*, *U. elongata*, *U. radiata*, *U. pendula* and *U. indica*, with similar general characters, were collected by the "Investigator" from other localities in the eastern part of the Indian Ocean at depths of 290–1803 fathoms. The type-specimen of *U. huxleyi* was found by the "Challenger" expedition at 565 fathoms off Yeddo, Japan, but Kükenthal and Broch (1911, p. 290) described a specimen from Great Nicobar which they identified as *U. huxleyi*. Two species, which I identified (1916, pp. 133, 134) as *U. jordani* and *U. pellucida* respectively, came from great depths in the Malay Archipelago.

All these species have one striking character in common—the absence of spicules in the autozooid and rachis. They have autozooids which are small as compared with those of some other species of the genus, and most of them (perhaps all) have a square axis.

The study of the numerous specimens in the "Murray" collection, and the comparison of selected specimens with the figures and descriptions of the species named above, has led definitely to the conclusion that they all represent stages of growth or of sexual condition or of post-mortem stages of one species, which by the law of priority should be called *U. huxleyi* (Kölliker, 1880).

If this view is correct, the species presents us with another example of the widespread distribution of the deep-sea Alcyonaria. If it is not, it would afford a quite exceptional case of several closely related species living in the same deep-sea area.

Pennatula inflata Kükenthal.

Pennatula inflata, Kükenthal and Broch, 1911, p. 350.

Occurrence.—Station 145, Maldive Archipelago, 510 metres; two specimens of a *Pennatula* belonging to the "grandis" group of species.

Descriptive Notes.—These are large fleshy sea-pens with numerous large lanceolate leaves, with pads or stripes of siphonozooids on the dorsal side of the rachis, leaving a broad bare track between them. A very characteristic feature of these species is the presence of a very thick swelling at the junction of the rachis and stalk, due to the presence in the subjacent tissues of a powerful sphincter muscle. They are all inhabitants of deep or very deep water.

Several specific names have been given to specimens belonging to this group from N. Atlantic waters (*e. g. P. grandis*, *P. borealis*, *P. bellissima*), but it seems probable that these are only varieties of one species, which should be called *P. grandis* Ehrenberg.

In 1911 (p. 350) Kükenthal and Broch gave a full description of nine specimens of a Pennatulid found off the coast of Somaliland in 628–741 metres of water which they named *Pennatula inflata*.

The differences between *P. inflata* and typical examples of *P. grandis* are not very important and are quite overshadowed by their resemblances, but before we can reach the conclusion which future discoveries will probably reveal, that *P. inflata* is only a variety of the widespread species *P. grandis*, a more detailed knowledge of the variation of the North Atlantic species is necessary.

The two principal characters given by Kükenthal and Broch to distinguish *P. inflata* from the other species of the "grandis" group are:

1. That the groups of siphonozooids on the dorsal surface are usually not connected with one another.
2. That one of the eight terminal spines of the calyx of the autozooids is longer than the others.

The arrangement of the siphonozooids in the "Murray" specimens agrees with that given in the descriptions of the type. On the dorsal side of the rachis there are curved pads (Wülste) of siphonozooids grouped round the edge of the leaves. They are quite distinct from one another in the lower part, but become more or less continuous in the upper part of the rachis.

In *P. grandis* the dorsal stripes of siphonozooids are said to be continuous. It would be interesting to know if in any specimens these stripes are discontinuous as they are in *P. inflata*. But, in any case, this is not a character of great systematic importance.

When horizontal sections of these pads are examined it is seen that they bear two kinds of zooids. There are numerous typical siphonozooids with a diameter of about 0·3 mm., and a smaller number of much larger zooids with a diameter of about 0·9 mm. The latter, with their wide open stomodæum, eight complete mesenteries with muscles on some of them, inconspicuous siphonoglyph and no tentacles, agree with the type of zooids I described as Mesozooids in *Pennatula Murrayi* (1916, p. 194). This is probably not a point of difference but of resemblance between *P. inflata* and *P. grandis*, as in the latter species peculiar large zooids were long ago observed by Sars and Kölliker, and in later years were described as "Geburtsöffnungen" by Balss (1910, p. 53). Their function is

certainly not that of oviducts, but most probably that of safety valves to allow a rapid expulsion of water from the tissues in case of alarm (see Hickson, 1916, p. 194).

Judging from the little we know of the natural history of the sea-pens, it seems very probable that when disturbed by the dredge these fleshy species discharge a large quantity of water from the tissues, and when the specimens arrive at the surface and are preserved they are considerably deflated. The prominent swelling at the junction of the rachis and stalk may not be noticeable in the fully-inflated condition, but owing to the large sphincter muscle cannot contract to the same extent as the other tissues and becomes prominent. It is really the result of deflation, not of inflation. In the specimens described below there is also a single row of siphonozooids running between the leaves from the dorsal pads to the ventral edge of the leaves, as in the type of *P. inflata* and in *P. bellissima* (Fowler, 1888, p. 135).

As regards the second character, the autozooids composing the leaves are attached to one another at the base, but a considerable but very variable part of each of them is free. This free part is protected by a sheath of needle-shaped spicules, terminating in eight spinous groups. In our specimens, as in the type, one of these groups is usually decidedly longer than the others. But owing to the damaged state of many of the leaves it is difficult to say whether this is a constant character, and constitutes a real specific distinction of *P. inflata* from *P. grandis*.

There can be no doubt that the " Murray " specimens from the Maldives belong to the same species as the " Valdivia " specimens from the coast of Somaliland, and in my opinion they should be named *Pennatula inflata* for the present, leaving the question of the identity of *P. inflata* and *P. grandis* for further critical examination.

A brief description of the two specimens is necessary.

The total length of Specimen A is 325 mm. and of specimen B 320 mm. The largest of the nine " Valdivia " specimens was 244 mm. and the smallest 44 mm. in length.

The relative length of rachis to stalk is—

Specimen A : Rachis 270 + stalk 55 = 325 mm.
,, B : ,, 260 + ,, 60 = 320 ,,

In agreement with Jungersen I consider the boundary between the stalk and rachis to be the ridge-like edge of the sphincter swelling. Kükenthal and Broch seem to have taken the lowest leaf as marking this boundary. Bearing this in mind, the relative lengths of stalk and rachis do not afford a satisfactory distinction between *P. inflata* and *P. grandis*. The breadth of the rachis cannot be determined in these crumpled specimens with any degree of accuracy.

The number of leaves on each side of the two specimens is 35 or 36. In the largest " Valdivia " specimen the number was only 24 or 25.

One of the largest leaves in Specimen B was about 70 mm. in length along its outer border and bore about 25 autozooids.

The spicules seem to be quite identical with those of the type.

In a few partially-expanded autozooids no spicules were observed in the tentacles : in this respect the species differs from *Pennatula grandis* according to Kükenthal and Broch (1911, p. 350).

Colour.—The rachis of specimen A is red, of specimen B yellowish brown. In both specimens the stalk is colourless.

Gonads : Both specimens were female. The largest ova were about 0·9 mm. in

diameter. They were captured at the beginning of March, but, judging from the appearance of the germinal vesicles, they were not nearly ripe for spawning.

Scytalium splendens (Th. & H.).

Pennatula splendens, Thomson and Henderson, 1906, "Investigator" Reports, Pt. I, p. 116.

Occurrence.—Station 145, Maldive Archipelago, 510 metres. There is only one specimen of this genus in the collection, and this is probably identical with *Scytalium splendens* from the Andaman Islands, 55 fathoms.

Descriptive Notes.—The specimen was unfortunately very severely mutilated when captured and some characters cannot be determined.

It has a total length of approximately 350 mm., of which 310 mm. belong to the rachis and 40 mm. to the stalk. There is a well-marked swelling, 10 mm. in diameter, in the sphincter region between stalk and rachis.

The largest leaves have a length of 40 mm., and they are composed of thirty to forty autozooids arranged in a single or double row.

The spicules have the size and shape characteristic of the genus, *i. e.* they are oval or "biscuit-shaped"* corpuscles with a maximum diameter of 0·06 mm.

The colour of the rachis is dark red, of the stalk white speckled with red. The partially expanded autozooids are yellow.

Neither the exact number of the leaves nor the distribution of the siphonozooids could be determined in this mutilated specimen.

There were no gonads in this specimen dredged at the beginning of March.

There is no difficulty in distinguishing specimens belonging to the genus *Scytalium* from other Pennatulids. The spicules are quite peculiar to it, and cannot be mistaken for those of any other genus.

Unfortunately Kölliker (1872, p. 233) used the expression "Lange schlanke Seefedern vom Habitus der Virgularieen" in his original description of the genus. This phrase is applicable to the type of the species *S. sarsii*, which was nearly 500 mm. in length and bore numerous very small leaves only 2 mm. in length, but it is not so to the species *S. splendens*, of which the type-specimen was 340 mm. in length and bore leaves 23–25 mm. in length, nor to *S. veneris*, nor to *S. balssii*. These are not slender sea-pens, but have leaves which are comparatively large, and in form resemble species of *Pennatula* far more closely than any of the Virgularians.

As I have pointed out (1916, p. 179), not only in form but also in general anatomy *Scytalium* is more closely related to *Pennatula* than to *Virgularia*, and its proper place is in the family Pennatulidæ and not in the family Virgulariidæ.

There is exceptional difficulty in dividing the genus into well-defined, specific groups, as the spicules of all the specimens are almost identical.

Scytalium tentaculatum and *S. balssii* seem to differ from the others in the presence of a single digitiform process on the calyx of each autozooid. The species described by Thomson and Henderson (1906A, p. 115) under the name *Pennatula veneris* may be distinct on account of the peculiar whip-like development of the terminal autozooid and some other minor characters.

* The expression "biscuit-shaped" is applied to flat oval spicules with a constriction in the middle like an hour-glass.

The other species may be divided into two groups, *S. sarsii* and *S. martensii* with small leaves bearing only a few autozooids, and *S. splendens* with large leaves bearing numerous autozooids.

This character is admittedly not a very satisfactory one for distinguishing species from one another, as it is liable to considerable variation, but a comparison of the measurements of all the specimens that have been described does show a distinct discontinuity between the large-leaved and small-leaved species.

In his description of a specimen from Japan which he called, erroneously in my opinion, *Scytalium martensii*, Kükenthal (1911, p. 315) suggested that the larger leaves bearing more numerous autozooids in his specimens, as compared with other specimens of *S. martensii*, was a difference due to age (" Altersunterscheide ").

This view does not seem to be in agreement with facts which have since been discovered. In the " Siboga " collection, among 100 specimens of *Scytalium martensii*, I measured one with a total length of 600 mm. and leaves only 2 mm. in length bearing 10 autozooids. Kükenthal's specimen was only 420 mm. in length and had leaves 29 mm. in length bearing 60 autozooids.

Several other examples could be quoted of short-leaved forms having a greater length than the large-leaved forms. As we know nothing at present about the growth stages of any one species, these facts do not prove definitely that Kükenthal's view was wrong, but they do justify the retention of the character " large-leafed " to distinguish *Scytalium splendens* from *Scytalium martensii*, which is " small-leafed ".

Since the discovery of the type-specimen of *S. splendens* in the Andaman Islands, Balss (1910, p. 49) has recorded the occurrence of several specimens, which he correctly referred to this species, in Japanese waters. Some of these came from shallow water in Sagami Bay.

In the following table a comparison of the measurements of two short-leaved forms with those of three specimens of *S. splendens* may be made :

	Total length.	Length of leaves.	Number of autozooids.
S. martensii (" Siboga " Exp.) .	600 mm. .	2 mm. .	10
S. sarsii (" Siboga " Exp.) . .	525 + mm. .	2–5 mm. .	25
S. splendens (type) . . .	340 mm. .	25 mm. .	60
,, (Japan) . . .	600 ,, .	26 ,, .	50
,, (" Murray " Exp.) .	360 ,, .	40 ,, .	30–40

It will be seen from these figures that the " Murray " expedition specimen from the Maldives differs from the other two in having much longer leaves, bearing comparatively few autozooids, but it is in no way intermediate between the short-leafed and the long-leafed species.

Thomson and Simpson (1909, p. 283) described an interesting specimen from 60 fathoms in the Andaman Archipelago with a total length of 285 mm., and with leaves 5 mm. in length bearing eighteen autozooids. They named it *Scytalium martensii* var. *magnifolia*. Kükenthal was probably right in suggesting that this specimen should more correctly be named *S. sarsii*.

Pteroeides sp. ? juv.

? *Godeffroyia elegans*, Kölliker, 1872, p. 116, pl. viii, figs. 63–65.
? *Pteroeides dofleini*, Balss, 1910, p. 59.

Occurrence.—Station 43, off the S. coast of Arabia, 95 metres. Five small specimens belonging to this genus were collected. They are all probably juvenile forms of some undetermined species.

Descriptive Notes.—Their measurements in millimetres are :

	1.	2.	3.	4.	5.
Total length	58	52	58	58	58
Length of rachis	38	37	?	42	38
Length of stalk	20	15	?	16	20
Longest leaves	12	12	12	12	12

The number of leaves is difficult to count accurately without dissection, but it appears to be twelve to fifteen large plus three to five rudimentary on each side.

The characteristic feature of the leaves is the presence of a very thick dorsal ray composed of several stout overlapping spicules. A number of very slender spicules project from the margin of the leaf, and numerous other slender spicules which do not project penetrate the leaf for a distance of about two-thirds of the width of the leaf, but do not reach its base, leaving a space of about one-third of the width of the leaf free from spicules.

Apart from the dorsal one there are no well-defined rays, but only a large number of slender spicules supporting the outer two-thirds of the leaf.

The siphonozooid plate is basal.

With these two characters the specimens agree most closely with the species originally described by Kölliker as *Godeffroyia elegans* from Siam. At a later date Balss (1910, p. 63) described three specimens from Japan with similar characters, which he called *Pteroeides dofleini* ; but according to Kükenthal this species is identical with *Godeffroyia elegans*, and the specific name " *elegans* " being preoccupied by one of Herklots' species, the name *Pt. dofleini* should stand as that of Kölliker's original species.

All the specimens described by Kölliker and Balss, however, are much larger than any of the " Murray " specimens, ranging in total length from 134–273 mm., and it seems to be a very open question whether these small specimens, 58 mm. in length, from Aden, would grow up with characters similar to those of *Pteroeides dofleini* from the far eastern seas.

Several species of the genus have been described from the east coast of Africa, but the only one which is said to possess a strong dorsal ray and a basal siphonozooid plate is *Pt. isosceles* of J. S. Thomson (1915, p. 17) from 32–38 fathoms off the coast of Natal. The single specimen of this species was 173 mm. in total length, and it bore eighteen rays on the leaves in addition to the strong dorsal ray. It was captured in November, 1900, and bore well-developed gonads.

It seems possible that definite secondary rays might develop from the small spicules of the leaf of the " Murray " specimens if they grew to the size of *Pt. isosceles*, in which case it would be difficult to distinguish them from that species.

Of the species from Zanzibar described by Thomson and Henderson (1906b, p. 438), the only one that might possibly be an adult form of that represented by our specimens

is *Pteroeides rigidum*, 230 mm. in length. It has a variable number of rays (four to six) and a basal siphonozooid plate; but no mention was made of a strong dorsal ray in this species.

The genus *Pteroeides* is widespread in the shallow waters of the tropical and sub-tropical waters of the Old World. In the Indian Ocean seventeen species have been described from the Bay of Bengal by Thomson and Simpson (1909, p. 287) and three species from Zanzibar by Thomson and Henderson (1906B, p. 438); and there are also some earlier records from various localities.

No less than sixty species of the genus have been named, some from isolated and damaged specimens, others from small and therefore probably young specimens. The difficulty of identifying two or three specimens from a new locality is often insuperable, and the tendency to make new species is difficult to resist. The systematics of the genus cannot be placed on a really satisfactory footing until a study has been made of a long series, from small to full-grown, of specimens of the same species from the same locality, in order to ascertain the development in growth of the rays, the siphonozooid plate, the ratio in length of the rachis and stalk and other characters that have been used for the systematic determination of species.

In the present case the only available specimens are very much smaller than adults of other well-known species of the genus, and they are most probably only young stages in the growth of a species which reaches a much larger size. It is therefore better to wait until fresh material is obtained from the same or a neighbouring locality before giving them a new specific name.

Some Additional Notes on the Anatomy of the "Murray" Specimens.

There are twelve or thirteen large leaves and three to five rudimentary ones on each side of the rachis. The large leaves are roughly triangular in outline, reaching a length of 12 mm. along the dorsal border, and a breadth at the base of about 3 mm. The outer margin is somewhat crinkled, but I have been able to count thirty-six autozooids on some of the largest leaves.

The dorsal ray consists of six to eight large, thick, smooth needles, tightly pressed together and overlapping one another. Some of these are 5–6 mm. in length and 0·2 mm. in diameter. The other spicules of the leaf are about 2 mm. in length and 0·06 mm. in diameter. It is difficult to measure accurately many of the spicules when *in situ* in the leaf, and there is, of course, a considerable range in size. The sizes given are those of the largest spicules that could be conveniently measured. But the most striking feature is the great difference in thickness between the spicules of the dorsal ray and all the others.

The siphonozooids are densely crowded together at the base of the leaves to form what is technically known as the basal plate. This plate extends under the dorsal ray for a distance of 4 mm. from the base; it then slopes down to a distance of 1·8 mm. from the base, and at the ventral edge it is only 0·6 mm. from the base. As in most of the species of *Pteroeides* (see Lightbown, 1917, p. 16), there are no mesenteric filaments on these siphonozooids. The stomodæum, as seen in whole mounts, is about $0{\cdot}1 \times 0{\cdot}05$ mm. in cross-section.

Colour.—The specimens are cream-coloured, with very variable but not very extensive patches of black pigment.

Gonads : There is no trace of gonads in the two specimens examined. The date of capture was October 28th.

An Unidentified Pennatulid.

In a tube labelled " Station 145, in the Maldive Archipelago, 494 metres ", there is a very badly preserved Pennatulid which, at first sight, I mistook for a specimen of *Funiculina*.

On the scraps of fleshy substance which remain attached to the axis there are some cylindrical projections similar to the autozooids of a *Funiculina*, but on clearing in oil they were found to be so badly macerated that even the tentacles were not clearly defined, and no trace of siphonozooids could be seen in the surrounding cœnenchym.

The first point to be noticed is that there were no spicules either in the autozooids or the general cœnenchym, but thinking that they might have become macerated off I examined the deposit of mud and other debris at the bottom of the tube and found no spicules.

The second point was that the axis is perfectly cylindrical throughout its whole length, and considerably thicker than that of even the longest specimen of *Funiculina*. It is evident that a considerable piece at the upper end of the specimen has been broken off and lost. What remains has a total length of 380 mm.

The diameter of the axis in the middle of its length is 1·5 mm., but this increases in the upper region of the stalk to a diameter of 2 mm.

Owing to the macerated condition of this specimen it is impossible to determine its systematic position. The cylindrical axis and the absence of spicules prove that it is not a *Funiculina*, and the absence of spicules indicates that it is probably not one of the Protoptilidæ.

The autozooids as preserved are about 5 mm. in length by 1 mm. in diameter, and on one fragment there is a definite arrangement of four in a row. This character suggested that it might be one of the Virgulariidæ, which also have a cylindrical axis and no spicules. The remarkably long and slender autozooids render this suggestion improbable. The only other Pennatulid of great size with a perfectly cylindrical axis and no spicules in the rachis is the *Osteocella septentrionalis* of British Columbia, and in this species the autozooids are of great size (4–5 mm. in length) and arranged in rows.

With the information at our disposal, however, it would be hazardous to identify this specimen from the Maldives with a species so far off and so far north as *Osteocella*.

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